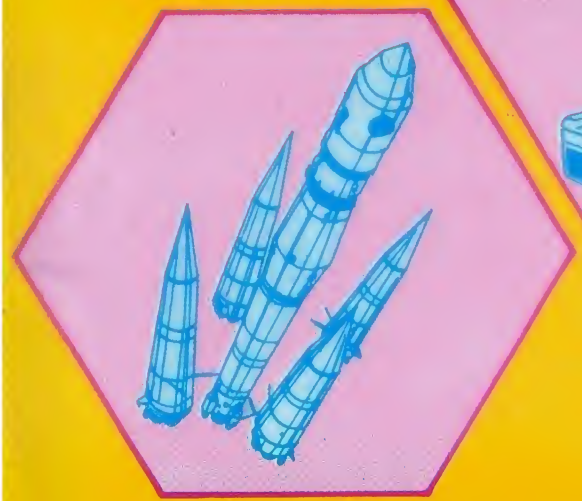
Inventions
That Shaped The World



MADHUBAN

Inventions

That Shaped The World

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ALFRED NOBEL

Dynamite

Alfred Nobel, one of the greatest inventors of the century, was a sickly child. He was never allowed to play with boys of his age, and he had to lie on his back for days at a stretch because of a weak spine. The result was that young Alfred read a lot, and by the age of 15 he knew history, literature and philosophy, and learnt five languages—an ability which helped him later in expanding his business.

When Alfred was born on 21 October 1833, in Stockholm, Sweden, his father was a penniless man. A man of inventive talent, his business venture in manufacturing rubber had failed, so when he came to know that the Tsar of Russia's navy needed sea mines, which he had himself invented, the elder Nobel decided to go to St. Petersburg (now Leningrad) and try his luck. The entire family shifted to St. Petersburg, where the business flourished and the family grew prosperous.

At the young age of 16, Alfred was asked to leave his studies and help in the family business. It was on a business tour to the U.S.A., that he first understood the role an explosive could play during peace time, namely, in

building rails, roads, tunnels, and in coal mines and stone quarries.

Meanwhile the Crimean War between Russia, on one hand, and England and France, on the other hand, had begun, and Alfred realised how ineffective his father's sea mines were. In those days mines were square boxes filled with gunpowder. Long iron poles were stuck to the sides, which, when hit by a ship, would break a glass tube to produce a flame or spark, and set the gunpowder off. Alfred realised the need for a more powerful explosive, but when the war ended in 1856, the family business collapsed, bringing ruin to the Nobels, who had to return to Sweden.

At this juncture Alfred began experiments with the newly discovered "explosive oil" for the mines. The "explosive oil" was nitroglycerine, a pale yellow, oil-like mixture of glycerine, nitric acid and sulphuric acid. It needed only a mild shock to set it off. The oil was therefore very dangerous to handle, and many careless scientists were seriously injured.

In those days nitroglycerine was set off either by hitting it with a hammer or throwing it away like a stone. Alfred found that if the explosive oil was to be used for a meaningful purpose, both of these methods were unsuitable. Eventually, he asked himself: why not use the gunpowder to set off the explosive oil? He took a small bottle and filled it with nitroglycerine. The bottle was capped and

Alfred Nobel.

inserted in a tin can filled with gunpowder. The can was immersed in a water ditch, and the wick, which was already inserted in the gunpowder, was lit. The can exploded with tremendous power, shaking the ground and throwing water all around. Alfred was quite happy with the result. This principle of using

an explosive of smaller power to set off another explosive of higher power was the greatest advance made since the discovery of gunpowder.

In late 1863, Alfred gave the final shape of a cylindrical wooden stick to his new explosive. At one end of the stick was the wick and the other end the gunpowder. The glass tube containing nitroglycerine was embedded in the gunpowder. When Alfred was about to start the manufacture of the explosive oil, a tragedy struck him. His laboratory in Heleneborg, a suburb of Stockholm, was blown up while he was away, killing his younger brother, Emil, and five workers. Fortunately, he was not prosecuted, but because of the explosion, he knew he would not get the licence to manufacture in Sweden, so within a few months he moved to Hamburg, Germany, where he set up a factory, and was soon

Alfred Nobel's laboratory.

exporting to many European countries and the U.S.A.

However, the new explosive needed extreme care while handling, which was not always possible because it was sent to distant places. The news of accidents began to come from all parts of the world. An entire ship blew up in Panama, and a warehouse in San Francisco exploded killing many people. Even Alfred's own factory was reduced to ashes in a fire. Finally, the Governments of some countries banned the explosive, while others made laws to penalise the manufacturers if it caused any damage.

Alfred soon realised that if he did not give a quick solution to the problem he was ruined. After examining many accidents he saw that most of them occurred because the explosive was a liquid, and he set out to solidify the explosive oil. When all his efforts failed, he began to look for a material that could absorb the oil and retain its explosive power. Materials such as powdered charcoal, brick dust, saw dust, and even cement were found useless.

One day on a visit to the packing room of his factory he found that an explosive oil container was leaking, but to his surprise, the clay surrounding the container had totally absorbed the oil. The clay was not of the ordinary kind. It was kieselguhr, the silica deposits of the fossils lying under the ground for over millions of years, which was found in plenty

near Hamburg. Earlier, Alfred had instructed his workers to pack the containers in crates with kieselguhr instead of sawdust because the latter was found ineffective in checking leakages. Now that he had seen the absorbing power of kieselguhr, he decided to check in his laboratory whether it was suitable for his purpose or not.

His laboratory tests showed that he could not have got a better absorbent for his explosive oil. Kieselguhr not only remained granular after absorbing the oil, but fully retained the explosive power of the oil. Alfred, however, did not start the manufacture of his new safe explosive immediately. Already his explosive oil had brought him and his companies a bad name. For a year or so he therefore carried out tests on the new solid explosive. When sure of its safe workings, he patented it under two new names, Nobel's Safety Powder and Dynamite. The latter name was adopted after the Greek word "dynamis", meaning power.

Within a few years of the manufacture of dynamite—as it came to be known all over the world—Alfred Nobel became one of the richest men in the world. One after another his factories came up in many foreign countries and his dynamite was sent all over the world, even playing an important role in the wars that were fought soon after the invention. Meanwhile, the Swedish Academy of Science awarded Alfred Nobel a gold medal.

Nobel Prize medals for Physics and Chemistry.

Subsequently, Nobel also invented "Cordite" or "blasting gelatine" which has greater destructive power than dynamite. Today it is used for blasting out tunnels and for underwater explosions. Besides his inventions in explosives, Nobel also dabbled with many new ideas in synthetic rubber, aerial photography, and blood transfusions, though without much success. However, as he said, "If I have a thousand ideas a year and only one turn out to be good, I'm satisfied."

Nobel did not marry at all. So when he grew old, he was a lonely man, and his entire wealth had no heir. He strongly believed that after seeing the horror that his explosives could wrought on the people, warring nations would keep off from warfare—a wrong belief as we know today. Under the strong influence of his secretary, Bertha von Suttuer, a peace worker, he began to feel he should do something great in the cause of peace. He therefore wrote a will

in which he donated his entire fortune towards the creation of the now prestigious Nobel Prizes. The will was found in his desk when he passed away suddenly in 1896.

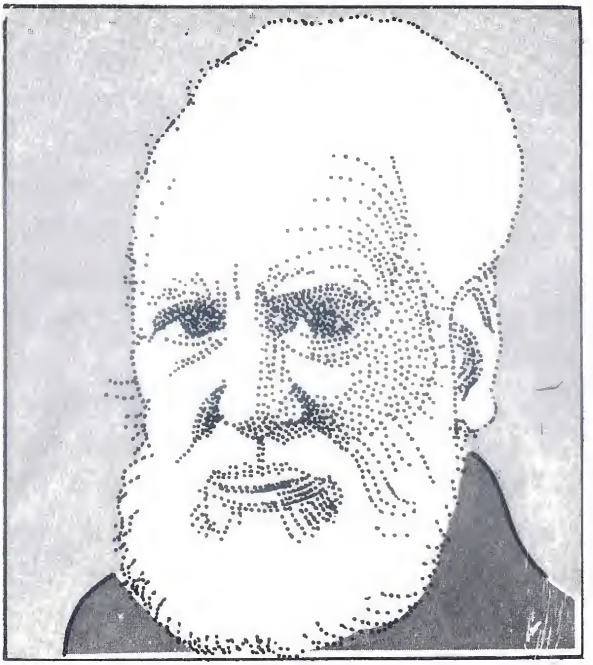
Nobel Prizes are awarded each year to those who make significant contributions in the cause of peace, physics, chemistry, medicine, economics and literature.

ALEXANDER GRAHAM BELL

The Telephone

The young Professor of Speech, Alexander Graham Bell, had fallen in love with his pretty student, Mabel Hubbard. The girl was, however, deaf. Bell had, therefore, promised her that he would invent a machine which would enable her to understand what was being spoken. However, despite his best efforts, he failed to invent such a machine, and had meanwhile exhausted all his resources. Mabel's father, Gardiner Hubbard, was a rich man and he was anxious that Mabel should learn to speak. He decided to give Bell all the money he required for his experiments. Thus began the joint enterprise which led to the invention of the telephone.

Bell was born on 3 March 1847, at Edinburgh, England, in an environment which helped him to understand the fundamentals of sound. As



Graham Bell

his mother was deaf, he learned the art of conversing with her at an early age. He also used to help his father, who had developed "invisible speech", a method of speaking with the deaf, in his experiments.

Electricity also captivated his attention, and he used to carry out experiments with it. Meanwhile the workshops and mills near his home stimulated his interest in machines. It was, however, on a visit to the home of the famous inventor Charles Wheatstone (who had invented the magnetic needle telegraph) that Bell was inspired to try his hand at inventing.

At an early age Bell started a private teaching school for the deaf. Meanwhile the family had migrated to Canada and Bell settled down in Boston, U.S.A. His inventive talent, however, did not allow him only to teach the deaf students. He also conducted experiments on them, and it was here that he met Mabel Hubbard and decided to invent a machine that would cure her deafness.

Forty years before Bell began his experiments, all the basic principles of the telephone had been discovered. Hans Christian Oersted had shown that a current through a wire coiled around an iron core magnetises the core. Michael Faraday had discovered that a moving magnet induces electric current in a coiled wire. So if sounds were produced near an iron diaphragm so that it would vibrate, which, in turn, would vibrate a magnet, a varying current would be induced in the wires. At the other end of the wires, the varying current passing through an electromagnet would, in turn, attract or repel the iron diaphragm reproducing the human sound.

All this looks obvious today, but it did not appear so when Bell began his experiments over an electrical shop in one of Boston's noisy side streets. His assistant was Thomas A. Watson, a worker from an electric shop. Their plan was to invent a "musical telegraph" in the beginning and later perfect it further to human speech.

Bell talking into his new device, watched by curious onlookers.

For his experiments Bell had a receiver and a transmitter in two rooms linked through wires via a battery. On a hot afternoon of June 1875, the battery had been disconnected. Between the experiments, which were all giving negative results, Bell was pondering what next he should do when he heard a hissing sound in the room. The vibrating reed of the receiver caught his attention.

Delighted and puzzled, Bell immediately called Watson and asked him whether he was fiddling with the transmitter. Watson told him he had just then fiddled with the reed of the transmitter because there was some fault in it. Bell instantly understood that the fiddling with the reed had caused the magnet to vibrate, which had, in turn, induced current in the wires to vibrate the reed at his end. His goal of sending human speech over wires was near at hand!

He forgot all about the "musical telegraph" and only concentrated on the telephone. When he told Hubbard about the new invention that was at hand, the latter called it a wild dream and advised him not to pursue it, but Bell paid no heed. However, for fear of further ridicule Bell kept the matter a secret.

For many months this went on—the fiddling of the reed at one end and its due reception at the other. At this juncture Bell's knowledge of the human voice and structure of the ear convinced him that a stretched membrane would be more suitable for sound reproduction than a reed. After much research his choice fell on an iron diaphragm, and finally, one day in January 1876, the long expected miracle occurred.

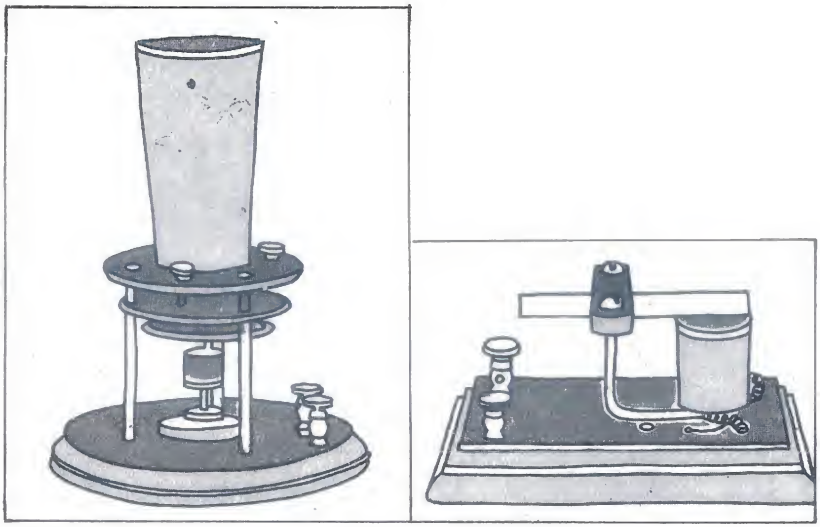
It so happened that Bell accidently upset a bottle containing acid and thus his clothes were spoiled. In sheer annoyance he shouted, "Mr Watson, please come here. I want you!"

Watson was in the other room. He rushed in to Bell's room and exclaimed in excitement, "I could hear you! It works!" Thereafter, the two young men carried on extensive experiments on the telephone.

Meanwhile Hubbard was informed of the success. He immediately got the invention patented and also began to think of manufacturing the telephone on a large scale. It was due to his prompt action that Bell is today recognised as the inventor of telephone. Only a few hours after the application of Bell's telephone patent was submitted to the patent office, Elisha Gray, another inventor, submitted an application for a similar device. However, it should be borne in mind that Bell is the real inventor of the telephone as we know it today, because Gray's device was a far cruder one.

At the suggestion of Hubbard only Bell took part in the International Centennial Exhibition held at Philadelphia, U.S.A. After going unnoticed for several days, Bell's invention suddenly came into the limelight here when the Emperor of Brazil, Dom Pedro II, took a keen interest in it. His words "Great Heavens! The Thing talks!" made Bell and his telephone famous overnight. Bell was then hardly 30.

In April 1877, a telephone line a few kilometres long, between Boston and Salem, was set up to show the public how song and music could be heard from a distant place. Subse-



The telephone—an early model known as the liquid phone.

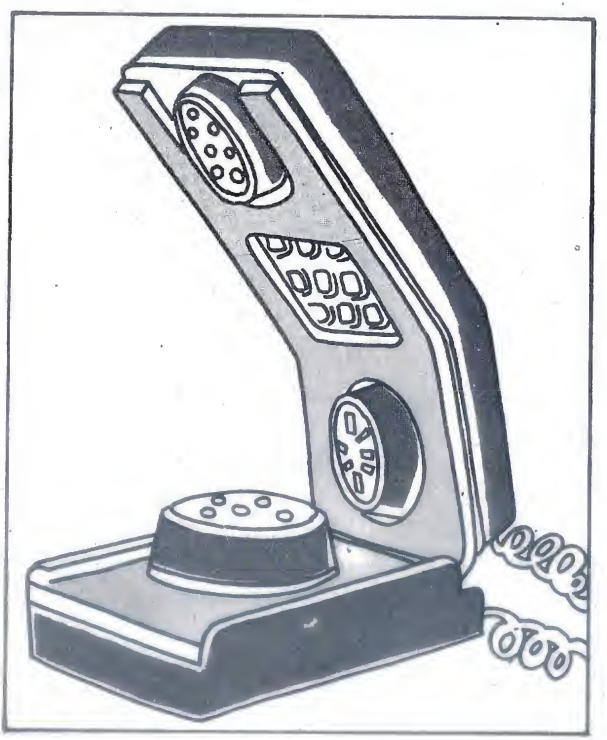
quently, the Bell Telephone Company was founded to manufacture telephones, and meanwhile Bell married Mabel Hubbard.

Bell proved to be such an able demonstrator that the telephone was soon accepted in many European countries and by the time he returned to the U.S.A. a telephone exchange had already been set up. The first exchange was installed at Brooklyn Heights, New Jersey, connecting about 100 telephones.

No sooner had the telephone exchange come into being, than it replaced all the older means of sending messages. In no time it brought in revolutionary changes in industry and urban life. Today, by means of satellites, one can talk to anyone anywhere in the world.

Bell grew wealthy but took no business interest in his invention. He was happy in his

workshop and conducting experiments for teaching the deaf to hear. Later he settled down on a farm in Nova Scotia to breed sheep, and it is believed he kept away from the telephone as far as possible! He always said that had he been an electrician he would not have invented the telephone. "What electrician would have hit upon so mad an idea?" he used to ask. When, at 75, he passed away in 1922, all the telephones in the U.S.A. were kept silent for one minute in his honour.



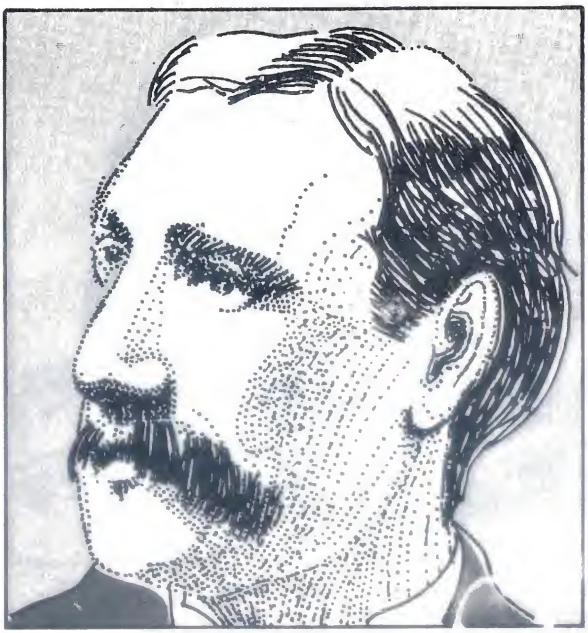
A sleek, modern version of the telephone.

W. FRIESE-GREENE

Cinema

Few know that the man who invented cinematography, the technique of film-making, was an Englishman called William Friese-Greene, and it is ironic that having created the greatest entertainment on earth he died in poverty.

Born in 1855, William Greene, as he was then known, was the youngest son of a metal craftsman of Bristol, U.K. Because the family was large, he had to start earning at the early age of 14. As he liked chemistry and physics at school, he took up apprenticeship in a photo studio. In those days photography itself was a



William Friese-Greene.

new born art and trade. So he learned the techniques of photography and in due course became a good photographer.

He was, however, not a good apprentice, for he always tried to do better than the studio-owner, which irked the latter, an old man, who himself was a pioneer in the field. His apprenticeship came to an end one day when he had a fight with the old man. He joined another studio shop in Bath, a nearby town. Meanwhile, he married a Swiss girl, Helena Friese, and changed his name to William Friese-Greene.

In due course Friese-Greene had his own photo studios. Although he made a lot of money, his ambition in life was to do something revolutionary in photography. He therefore did not leave experimenting with visual effects and reading books on new techniques. He also made friends with Fox Talbot, the man who developed the technique of making positive prints from a single negative plate. Talbot was an old man, who used to talk hours on end on photography. He saw the inventor in Friese-Greene, and advised him to go to London if he wanted to explore new ground in photography.

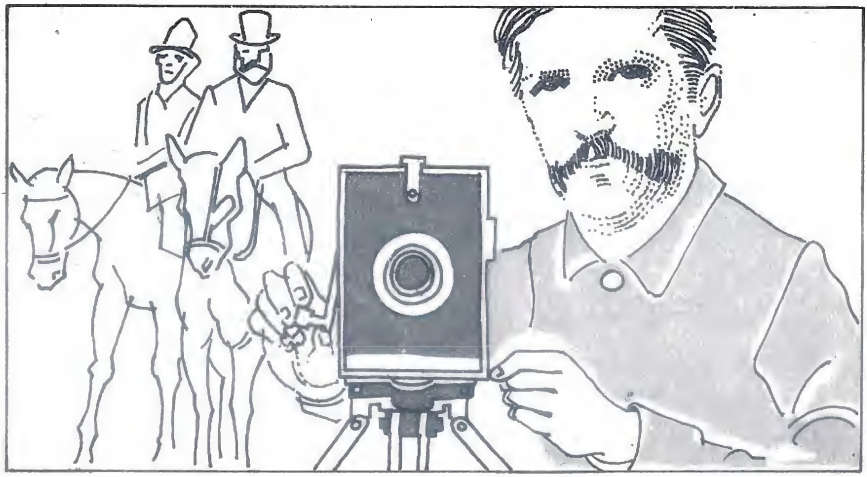
Meanwhile Friese-Greene had also become a good friend of another old man, John Arthur Roebuck Rudge, who had invented, among other things, what he called a "Biophantic Lantern". This invention could project on a white-washed wall the magnified image of a clown, who made a jerky somersault. It con-

sisted of a Lamp, seven glass slides and a lens. Then successive actions of the clown were drawn on the slides and they were moved one after another before the lamp and behind the lens. The lamp lit up the drawings on the slides and the lens magnified them. When Friese-Greene saw the somersaulting clown on the wall he was astounded.

Our eyes are slow in registering as well as in erasing the image of an object. If an object comes before them and vanishes soon after they would still see it for the next few moments, and if within these moments, another object appears, its image would blend with that of the first one. This phenomenon is called "persistence of vision". So when the slides of two successive actions of the clown came one after another, the eyes were tricked into believing that the clown had moved.

The time within which the slides have to appear and disappear before the eyes so as to produce the illusion of movement is a fraction of a second. Rudge showed Friese-Greene all the slides of the clown one after another, when each looked a motionless picture, and also when he moved them quickly so as to produce the illusion of movement in the pictures of the clown.

Friese-Greene thought, why not use photography to record actual movement instead of making drawings as Rudge had done? So began Friese-Greene's efforts to improve the inven-



tion from all angles. Friese-Greene prepared one set of four photo-slides which showed a girl moving her eyes from side to side and another set showing his own face changing from a frown to a smile. When he gave an exhibition of his new invention, his audience was dumb-struck. Some thought he was performing a magic trick. One old lady was so puzzled, she thrust her umbrella at the pictures and was surprised to find nothing there but a white screen. So overwhelming was the reaction that Friese-Greene decided there and then to go to London to perfect his invention.

In London Friese-Greene began to work on his invention in a systematic manner. He took up courses in mechanics, physics, chemistry and engineering, and frequently attended lectures by expert photographers of the day. Gradually his ideas began to take a concrete

shape. In 1885 Friese-Greene gave a demonstration of his invention to the members of the Royal Photographic Society of London. They were quite excited, and made him a member of their society, but did not consider it worth wasting their time on. Some even called him a crank.

Friese-Greene ignored the cold reception given to him and decided to test the public's reaction. In one of the windows of his studio at Piccadily he fitted in a white screen, and at night started projecting the figure of a dancing skeleton on the screen. In no time this exhibition of a unique dancing picture in one of the busiest streets of London made it the talk of the town. The result was traffic jam in the area every night, and when the police came to know the source of the disturbance they ordered Friese-Greene to stop his exhibition.

Seeing such an overwhelming response, he set about perfecting his invention. He knew that if his exhibitions had to have any effect they had to be of a longer duration. In other words the strips of material required both for taking photographs and their projection on the screen should be longer. He found that his strips tore away in the camara and the projector if more pictures were taken. Thus began his search for a material which was flexible, transparent and tough.

For several days Friese-Greene spent sleepless nights but without any results. When

finally he hit upon the material, it seemed as though it had been made especially for his purpose, so perfect it was. It was "celluloid" a compound of nitrocellulose and camphor, one of the first plastic materials. About 30 years before Friese-Greene's discovery, a British scientist, Alexender Parkes had produced it. He had, however, found it of no use because it was highly inflammable. Today, the entire film industry depends on this so that films are sometimes referred to as a "celluloid world". In no time Friese-Greene's laboratory became a celluloid-making factory. He finally produced a 16-metre long celluloid film strip coated with a light-sensitive emulsion. He accordingly redesigned his camera so that it could take pictures on the film strip by the turn of its handle.

On a Sunday morning of January 1889, Friese-Greene took his new camera with the film and went to London's famous Hyde Park. The day before he had asked his cousin Carter to meet him in the park without telling him the purpose. No sooner had Carter, with his little son, come into view, than Friese-Greene directed the camera at them and, turning the handle, began to "shoot" until they were almost at his side. As more film was still left he also "shot" the ladies and gentlemen in their Sunday morning attire and then the hansom cabs and horses in the street.

It was quite late in the night before the entire

film strip was developed. Nervously he turned the handle of the projector and the film began to move. In the red light of his dark room he soon saw, to his utter astonishment, his cousin Carter with his son approaching him right on the screen. Next he saw all the people and the cabs he had "shot" in the morning. His dream had finally turned into reality.

But meanwhile his business was going downhill and his experiments were eating into his income. Creditors soon began to hound him, and the situation became so bad that he was taken to court and imprisoned. His wife had to sell his property to get him released, but thereafter Friese-Greene had to take photographs to earn a living. Nonetheless, he continued experimenting till finally, in 1890, Friese-Greene was granted a patent for his wonderful invention, and the Photographic Convention held at Chester that year hailed him a genius.

Friese-Greene now wanted to make further improvements in his invention so that not only pictures but sounds and colours were reproduced. He was far ahead of his times, for it was only 40 years later that the first talking films were shown.

Though he had to sell his patent to a private firm owing to financial difficulties, it was fortunate that Friese-Greene saw his own invention becoming a booming business. Unfortunately, he did not get a nickel out of it

and was always penniless. Before he died he had said, "One day they'll make a film of my life". Indeed, after his death in 1921, the entire British film industry combined to produce the film, *The Magic Box*, on his life and struggles.

WRIGHT BROTHERS

The Aeroplane

On a cold night of 1879, Milton Wright, a Bishop of Dayton, Ohio, U.S.A. brought home for his children a new toy. When the spring in the toy was wound up and released, the toy shot up. It was a helicopter type of toy. The children clapped their hands in delight whenever the toy hit the ceiling, but two of the children, Wilbur Wright, aged 11, and Orville Wright, aged 7, had different ideas. The toy spurred them to build a large-sized model of the same, so that they could climb on and reach the clouds.

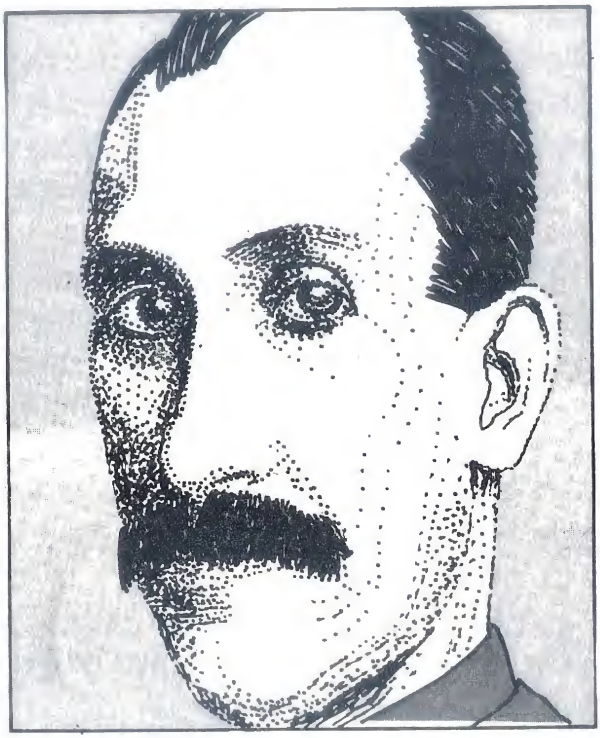
The idea was fantastic, but when the model was ready it refused to shoot up. The boys were amazed. It was more than 20 years later when the young men had invented the first flying machine that they understood why their childhood model did not fly. It is a fundamental law of flight that if the weight of an object is doubled, the force required to lift it into the air gets increased eight times.

Machines and kites fascinated the boys with the result that the boys could not complete their education, and later had no alternative but to go in for business. Because printing machines fascinated them, they started a small printing press, and brought out a weekly newspaper. He himself became its editor and made Orville the publisher. But when the weekly was turned into a daily, the venture failed, and the brothers began to look for a new business.

The bicycle had just entered the market and attracted their attention. The Wright Cycle

Wilbur Wright.

Company was thus established—a shop for selling cycles, and a workshop at the back for repairing them. Soon they began to build their own bicycles, and continued conducting various experiments.



Orville Wright.

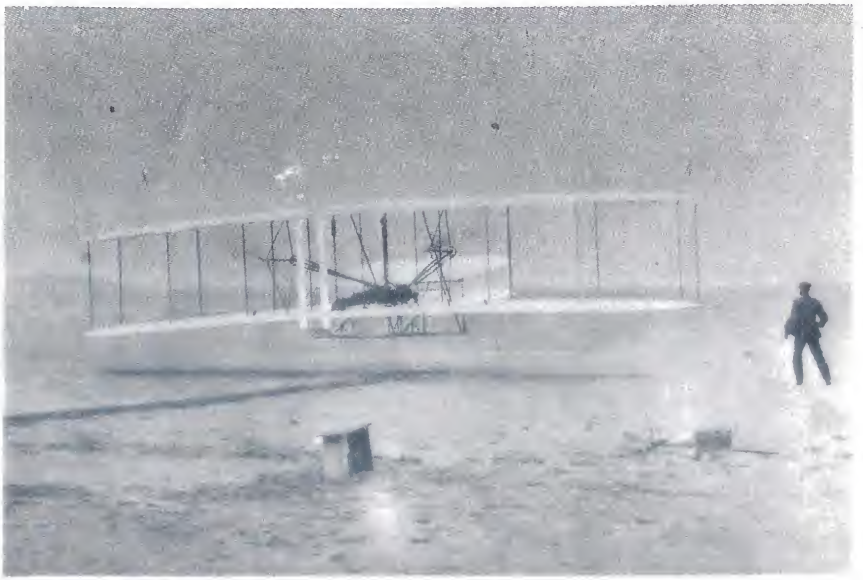
One day an article, *The Flying Man*, in a scientific journal attracted their attention. The article talked of Otto Lilienthal of Germany, who was using a 6.5 meter glider to fly like a bird. Their interest aroused, they now began their systematic reading on the subject of flying.

The two brothers were acquainting themselves with flying experiments when the news of the death of bird-man, Otto Lilienthal, reached them. Lilienthal died when his glider suddenly overturned in the air and fell to the ground like stone. The last words of the dying Lilienthal, "Sacrifices must be made", inspired them further. The death of the bird-man nevertheless served as a lesson to them not to be careless, and in their entire flying career none of them received any injury except severe scratches.

The Wright brothers first decided to find out what mistakes their predecessors had made and how to avoid them by use of the knowledge of aerodynamics—the study of air flow over smooth surfaces such as that of a glider. The next three years were spent in collecting data and in observing how birds and insects take off, fly, and land.

One problem struck them hard: how to prevent a flying machine from overturning when a sudden gust of wind hits it. It was by sheer chance that Wilbur hit upon an answer. For a customer one day he opened a cardboard box containing the inner tubes of bicycle tyres, when it suddenly struck him that the opening flaps of the box were bent while taking out the tubes. The flying machine could have such flap-like wings which could be bent and straightened as need be while flying. This thought now entered his mind.

To test whether such "warped" wings could be used to control the balance of the flying machine under all wind conditions, he built a model biplane kite. The wings of the kite were controlled from the ground by means of strings. Wilbur found the performance of the kite satisfactory. Based on the same principles, the brothers built a model glider. For testing its performance, they selected an isolated place named Kitty Hawk near the sea coast in North Carolina, after much consultation with the weather bureau. Not much far away from Dayton, Kitty Hawk was full of sands and empty of inquistive people, but unfortunately, as it later turned out, without the good wind for which it was selected.



The "Flyer" at Kitty Hawk.

After some initial setbacks, which are often met with in any new location, the Wright brothers began their epoch-making experiments at Kitty Hawk. A close friend meanwhile ran their cycle shop back at Dayton. Two gliders were built one by one at the site using the parts carefully made and checked in their cycle workshop. Quite surprisingly, none of them had a tail. In turns, the two brothers used to lie flat on their stomachs in the centre of the glider and glide down a small hill. But no great success was forthcoming. The brothers lost so much hope that Wilbur even remarked that man would not be able to fly for the next thousand years. However, at their workshop, new ideas began to enter their mind and they were back to their experiments.

The brothers decided to test their glider models first at home, for which they built a wind tunnel in their workshop. The tunnel was nothing but a cylindrical passage through which wind was blown by means of a petrol-driven fan. The tunnel provided wind conditions of various speeds as observed in nature. The brothers could thus observe how a particular shape of wings would behave in given wind conditions, and so could decide which wings suited their needs and which did not.

Without wasting much time, money or effort on full-sized model gliders, they could select the right wing shapes for their new

glider. Two problems then faced them—one was the right design for a propeller and the other that of a light engine—and both were somehow solved within no time.

Early in December 1903, the Wright brothers' new flying machine, called "Flyer", was completed. It had two wings 6.5 meters long, one over the other about two meters apart, and a tail. Two 2.5-meter wide propellers were at the back of the wings and were driven by a petrol engine. To the right of centre was the petrol engine, and to the left of centre, one of the brothers was to lie to balance the weight. The plane had to run on 20-meter long wooden rails before it could be launched into the air.

Who would be the first to ride the plane? The issue was decided on by tossing a coin. Wilbur won and rode the plane, but, unfortunately, the plane landed soon after it took off. One of its minor parts was also damaged while landing. The damage was soon repaired and the brothers began to wait for a good wind for the second flight. The next three days it remained windy and cold. Eventually, on 17 December, 1903, in desperation Orville decided to fly because Christmas was round the corner and they had to be back home at that time.

So despite the bad and cold wind of 38 to 40 kmph, Orville started the engine and got on the plane, lying flat on his stomach, his two hands clutching the various controls of the

plane. Wilbur accompanied him on the ground, his one hand holding one of the wings of the plane as the plane ran on the rails. For about 15 meters or so the plane ran on the rails and then took off. The next 12 seconds have gone down for forever in the history of flying. The plane rose up in the air and then slowly descended to land safely about 40 meters away from the point it took off.

Only four men and one boy witnessed the historic flight of the Wright brothers' plane. One of the men also took photographs of the plane while it was in the air. Subsequently, on the same day two more times the plane took off, stayed on in the air for a longer time and covered more distance. The second time it, however, crashlanded without harming Orville. The plane had nonetheless served the purpose and so the brothers happily called it a day.

Their father was informed on the telegraph. Apparently, the telegraph operator passed on the news to the newspapers. Subsequently, to keep off the press, the brothers carried on their flights secretly at a friend's farm near Dayton. By 1904 the two brothers had conducted more than 50 flights successfully, each time setting a new record of flying. In those early days their record was 38 kilometers covered in 33 minutes.

The Wright brothers wanted to sell their flying invention to their own country but the

authorities somehow did not show much enthusiasm, taking it to be no more than a toy. It was World War II which showed its usefulness, and when the brothers turned towards the French authorities, the U.S. government paid the Wright brothers handsomely for their invention.

The flying machine, however, did not catch the eye of the public until the Frenchman Bleriot flew across the English channel in 1909, and Charles A. Lindbergh crossed the Atlantic Ocean in a small plane in 1929. Wilbur Wright, the main driving force behind the invention, died in 1912, but Orville lived till 1947 when the flying machine had already started flying at supersonic speeds.

G. MARCONI

Wireless Radio

Ask anyone, who is the inventor of the radio? Marconi, will be the prompt answer. Guglielmo Marconi's name is known to any one who has some interest in science. This great inventor was born on April 25, 1974 at Bologna in Italy. His father, Giuseppe Marconi, was a wealthy Italian landowner who was always busy with his farm and business. His mother, Signora Annie, of Irish origin, took a keen interest in bringing up her children.

The young Marconi at work in his office.

From his childhood to the time he invented "wireless telegraphy", Marconi spent his life in the sprawling mansion, "Villa Griffone", near Bologna. Marconi showed unusual qualities from childhood. While Marconi's elder brother, Alfonso, would be with boys of his own age, Marconi remained aloof, reading most of the time.

Signora Annie was a very intelligent and wise lady. She knew the psychology of children. Marconi grew up under her guiding eyes. He was taught particularly to write and speak English which, in fact, was the language his mother spoke. When Marconi was in his teens, he was sent to college outside Bologna for higher studies. When in 1894, he returned from college, the very first day, he asked his mother to fix up two attic rooms for his study and to give him ten lires for some material he

wanted to buy. The attic rooms were being used by his father to store cotton, and it was with great reluctance that he cleared them.

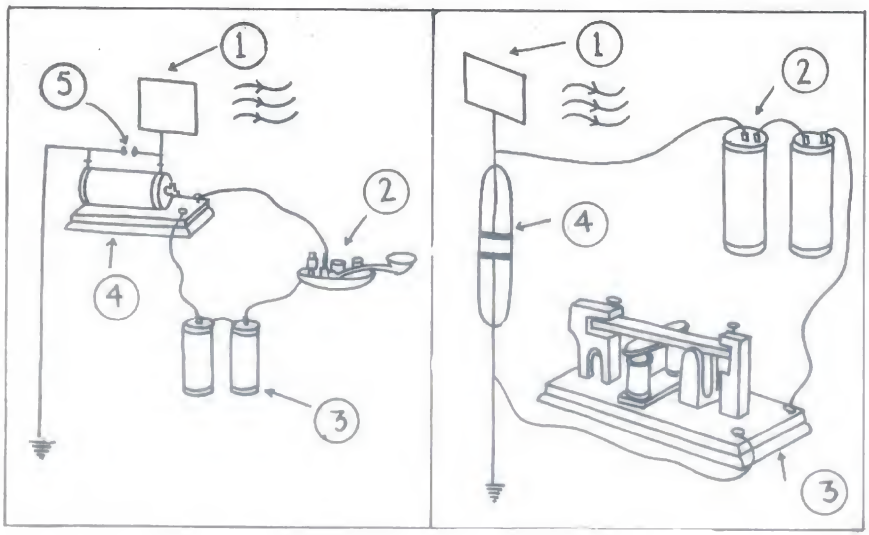
Thereafter, the 21-year-old genius was a virtual recluse in the attic, experimenting with radio waves. Although his father never bothered to find out what his son was doing, he was very anxious about his health, because he never met him during meals. Marconi's mother had a vague idea what he was up to, but never realised the importance of his work. However, she supported him every time Marconi's father raised an objection.

It was a cold December night of 1894. Young Marconi was concentrating on his experiments in the attic, while everyone slept upstairs. Suddenly, at midnight, an overjoyed Marconi ran straight to his mother's bedroom. His mother was ill, but on seeing her son so excited, she accompanied him to the attic. Marconi pressed the button and a bell rang in the other room! That was the first ever signal transmitted without any wire, over a distance of 10 meters. In the morning the experiment was demonstrated before the whole family.

Within months the range of Marconi's invention increased tremendously from ten meters to more than two kilometers. He built a powerful transmitter and also utilised the newly invented aerial for transmitting radio waves over long distances. One of his experiments, which enabled him to visualise the

immense application of his invention and helped him to gain the confidence of his father, was when he found his messages passing successfully across a hill. Thereafter, his father, too, helped him in every respect, while his mother had great plans in store for him. She wanted that her own country, England, should be the nation to give him due recognition, and thus arranged a demonstration of Marconi's experiment at London.

A large number of high dignitaries and officials gathered on the roof of the General Post Office building in St. Martin's-le-Grand to witness the exciting demonstration. Many were skeptical about the claims made by the young inventor. An assembly of equipment lay ready on the table. Everyone was puzzled as to



Marconi's early receiver

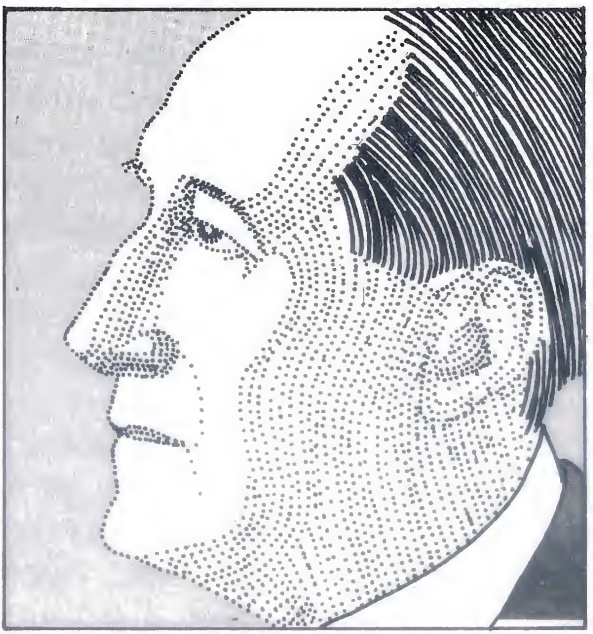
how signals could be sent and received without any medium such as a wire. Using the Morse Code, Marconi tapped a message to a receiver placed in a house situated about two kilometers from the G.P.O. Everybody was startled when the equipment seemed to return the message that had been sent a minute earlier.

As was expected, the invention created a sensation. The next day Marconi was the talk of the town. The newspapers put out a special feature on this miraculous invention. Though the common man could not understand its significance, the scientific world hailed Marconi as a genius, and he was called for demonstrations at various places. In 1898, wireless telegraphy was successfully adopted by a newspaper, the *Dublin Express*. The daily employed Marconi to cover the yachts race held at Kingston. With his equipment Marconi followed the yachts in a boat, and tapped out on-the-spot details to a receiving station located on the shore, which, in turn, forwarded the messages to the editorial office. This bold experiment secured him the first two contracts for installing transmitters in some isolated lighthouses off the Irish coast.

The Shipping Company Board also realised the usefulness of wireless for the safety and convenience of ships. The result was that ships were also installed with this wonderful invention, which duly helped in saving a large number of lives and property. A timely signal

by a ship in distress to any nearby ship or shore was enough to get the required help. Another incident which showed the usefulness of wireless telegraphy was when a criminal was captured as a result of a prompt wireless message. In 1907, Marconi was able to 'bridge' the Atlantic Ocean. He thus brought the two continents closer to each other in terms of communications.

The Marconi International Marine Communication Company was founded to develop Marconi's invention for safety at sea. However, the company was soon hopelessly entangled in political and economic intrigues. Frustrated, he left England to return to Italy, when



Marconi in his later years.

World War I broke out in 1914. During the war he modestly served as a lieutenant in the Italian army. By now wireless was a prominent feature on the battle front. After the war he was appointed a delegate to the Paris Peace Conference, but he found he disliked politics, and went back to his scientific pursuits.

Marconi bought a ship and named it "Elettra" after his daughter. He turned the ship into a complete laboratory for his research work. It was in "Elettra" that Marconi invented radio-telephony now known as "broadcasting". The first ever broadcasting was done when a concert in progress at the Savoy Hotel in London, was heard from the loudspeakers on the deck of the "Elettra". The radio was the last and most priceless gift that Marconi gave to mankind.

On July 30, 1937, Marconi passed away. He was the recipient of several honours including the coveted Nobel Prize, which he received in 1909 for his "distinguished services to mankind as well as science".

An interesting controversy exists regarding the invention of wireless telegraphy, since the Indian scientist Jagdish Chandra Bose also invented the same device in Calcutta in 1895. Bose's claim to the invention is, however, not given much consideration because he neither patented the device nor carried on further experiments as Marconi did.

Bose gave a demonstration of the working of

the device in the Town Hall of Calcutta, in the presence of the Lieutenant-Governor of Bengal, Sir Alexender Mackenzie. By means of radio waves he was able to fire a pistol in a room 25 meters away with three thick walls in between. The Lieutenant-Governor was so impressed that he immediately granted Bose Rs. 1,000 for further experiments.

Besides the device, Bose also invented the aerial—a pole with a metal disc. It was when he had already installed a six-meter high aerial atop his laboratory to send radio waves to his home, about 1.5 kilometer away, that he was asked to pack up his things and leave for England. His wireless experiments were thus stopped and he lost the claim for the invention.

R.H. GODDARD

The Rocket

Rockets made their first appearance in written records in a Chinese chronicle of 1232 which called it a "flying fiery arrow". It is narrated how rockets were used effectively against the Mongols when they laid siege of the Chinese town of Kai-fung Fu. In the Middle Ages, a lot of experiments were conducted to make rockets an effective weapon, but no written records remain. A book written in 1280

Robert H. Goddard.

described a missile which ran on rocket power. Rockets were even available in various shapes—such as those of pigeons or hares depending on whether they were to move in the air or on the ground. Multiple-rocket or rockets with steering fins were also available.

During the siege of Seringapatnam in 1797, the armies of Hyder Ali, and later of his son Tippoo Sultan, used a troop of rocketeers effectively against the British army led by Colonel William Congreve. It was the first time that a European army encountered rockets in a battle. From this time onwards, rockets were developed in Europe and began to

play a major role in warfare.

Born on October 5, 1882 at Worcester, Massachussetts, U.S.A., Robert Hutchings Goddard, the inventor of the modern rocket, was a studious and dreamy boy. From an early age he had developed the habit of noting down ideas that came to his mind. Once when he was in his teens, he had noted down some erroneous scientific ideas, and when he realized them to be faulty, he threw his notebooks into the fireplace! He had a very inventive mind, and he was only in his early 20s when he had conceived the use of nuclear energy for high speed railway moving on electromagnetic principles.

After reading a popular science book, Robert realised that if there was any scientific principle which would help his rocket to climb into the sky, that principle was the Newton's Third Law of Motion: "To every action there is an equal and opposite reaction." Like a gun barrel, which receives a kick backwards every time a bullet is fired off it, Robert imagined his rocket firing off bullet-like objects and in the process climbing up in the sky. Using home-made things he tested the law until he was convinced that it could be used for driving his rocket.

However, one day when Robert came to know that the space between the planets was empty—a total vacuum, he began to doubt whether Newton's law would operate in a vacuum. In those days, there was a wrong

belief that for an object to move, it had to push against something. As a vacuum contained nothing to push against, nothing could move in it. It was several years later, when Robert had a doctorate and was teaching at Clark University, Worcester, that he checked whether Newton's law holds good in a vacuum or not. He was triumphant when he found it operated in a vacuum, and he knew his rocket could then reach Mars.

In those days rockets were, at most, used in fire displays, and the rocket was nothing but a hollow tube. One end of the tube was closed, and the other was filled with explosive material such as black powder. When the powder ignited, the smoke thus produced pushed the tube in the opposite direction in accordance with Newton's law. Directed upwards such a rocket would go up not more than three meters.

Goddard found out that these rockets could not go higher because only three per cent of the explosive powder did the work. The rest just burned away as the rocket went up. Also, the shape of the rocket was such that it could not attain higher speed.

After much experimentation he arrived at a more streamlined shape for the rocket body. To increase the speed and range, Goddard conceived of a "two step" rocket. In accordance with the law of inertia, he felt that if a smaller rocket is fired off from a bigger one

Goddard with his rocket.

already at the end of its flight, the smaller rocket would attain a speed which would be the sum total of the bigger rocket's and its own speed.

For example, the speed of a ball thrown from a moving car is the sum total of the car's speed and the ball's, provided both are moving in the

same direction. Although Goddard carried on some research at Clark University, he needed a much larger sum for full-time research and testing of rockets.

Meanwhile World War I broke out. Goddard sent in an application to the military authorities describing his work and explaining how rockets could be used in warfare. The U.S. Navy hired him immediately, and he was able to continue his research on powder rockets. However, in 1918 with the end of the war, the military lost interest in his invention, and Goddard returned to Clark University a frustrated man. Who would finance his researches, was the question uppermost in his mind.

In 1919, Goddard finally wrote a monograph *A Method of Reaching Extreme Altitudes* based on his personal researches. He sent its copies to various institutes, organisations and societies. His purpose was to convince them of the worth of his work and get funds. Two institutions eventually approved of Goddard's work and gave him funds and he could now carry on his proposed tests on a full-time basis. Interestingly enough Goddard had made a casual reference in his monograph to the possibilities of sending a rocket to the moon.

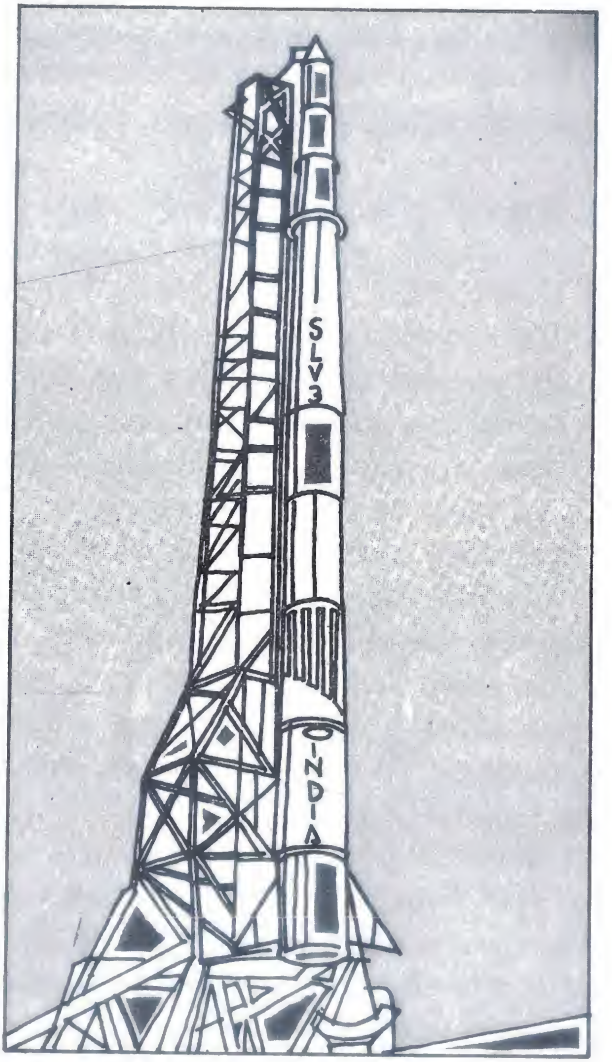
By chance a newspaperman noticed this remark and aware of the fact that Goddard was a Professor and not a crackpot, he immediately highlighted the "moon-rocket" possibility in

his newspaper, which subsequently appeared in other newspapers. Overnight Goddard became the talk of the town, which, quite surprisingly, depressed him. He was so averse to publicity that from that time onwards he always remained silent on his rocket researches. His activities became so secretive that newspapermen began to call him the "mystery Professor". Unable to find out what he was up to, the newspapers began to publish all kinds of fabulous stories of his rockets.

That solid propellents such as black powder were inadequate for driving rockets to higher altitudes was Goddard's contention for a long time. He wanted to try a liquid propellent. Which liquid would serve as a rocket propellent? His choice finally fell on oxygen and petrol, provided that he could find means to keep them separate and then allow them to mix just before the mixture could ignite for rocket propulsion.

He therefore incorporated in the rocket a complicated system of tanks, pumps, valves, tubes and engines to keep liquid oxygen and petrol separate and to allow them to mix before ignition. He began to fabricate steel, streamlined rockets with tanks and other arrangements for storing the liquid propellents.

On 1 October 1923, the first liquid propellent rocket was fired from the test stand at Auburn, Massachussetts. Subsequently, many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more tests were conducted. The real success, however, came on a winter day of March 1926 when snow covered the ground at Auburn and witnesses had gathered around the test stand rather reluctantly. The rocket went straight up into the sky up to a height of 62 meters within 25 seconds achieving a maximum speed of 80 kmph.

This success might seem a modest one, but it proved that liquid propellent rockets were possible. However, the loud blasts of the tests made people in the neighbourhood curious about what was happening. People began to flock to the testing ground and eventually the police turned up and asked Goddard and his assistants to stop their tests, which they did, shifting their site to Rosewell in New Mexico.

At the new site Goddard built from scratch the necessary installation, workshop, and a seven-meter high test stand for static experiments. His launching cradle was about 24 kilometers away, like a real rocket launching site. Here Goddard built several rockets each more sophisticated and larger than the other. Here for the first time he also launched a rocket that carried a barometer, a thermometer, and a small camera for studying the upper atmosphere.

His biggest rocket was about a quarter ton in weight, 7.5 meters in length and 45 centimeters in diameter, and the maximum speed and range his rockets could achieve were

respectively 880 kmph and 2,416 meters. These rockets were, indeed, the first real rockets, but in those days nobody understood their importance. One day Goddard's funds were suddenly stopped and so came to an end his researches and tests.

On 10 August, 1945 he suddenly died after a throat operation. Before he died he had come to know of the development of the German ground-to-ground missiles—V_1 and V_2—which the German rocket experts claimed were based on the design of Goddard's liquid propellent rocket. It is believed that had the U.S. military authorities heeded Goddard earlier, the Allies would have won World War II much earlier. Even in the space race, the U.S. would have beaten the U.S.S.R. by twenty years!

Inventions That Shaped The World

The book aims at introducing Alfred Nobel, the Wright Brothers, Alexander Graham Bell, and other lesser known legendary figures whose inventions have changed the face of modern times. The cinema, radio, telephone, the rocket, the aeroplane, the dynamite are things we take for granted in the modern world, not realizing that each invention has a fascinating story behind it.

It is this story that unfolds in the pages of this book, and so inspiring is it that it is sure to leave its mark on the young adults who read it.

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